30558/B

We are fearfully & wonderfully Made, & as fearfully & wonderfully preserved & kept in Being. Of which among innumerable other Instances y. Uses here assigned to y. Ganglions in y. Regulation of y. human System, serve as no inconsiderable Proof, if they are as just & well founded as they appear probable & ingenious. Whether this curious little Essay has as Much Theological as medical Merit & Ingenuity, as it Leads y. Mind to its Maker, & beautifully & striking Sets in View y. infinite Wisdom & Goodness that has limited y. Powers of y. Human Will over y. Human Frame; while y. very Minutiae or smallest Parts of That wonderfull Peice of Mechanism Man, are subservient to y. greatest & most important Purposes in Hand of y. Grand Artificer, & No less than y. Heavens, whole Frame of Nature, shew forth y. Glory of God.

Decem. 1784.

N.B. y. late Ld Lyttelton observed upon this Tract that it afforded a strong Argument agt. Suicide

N.B. from y. Author.

75512

A Gift of ye Author Aug. ye 6. 1784.

AN ESSAY ON THE USE OF THE GANGLIONS OF THE NERVES.

By *JAMES JOHNSTONE*, M. D.

> *In experimental Philoſophy Propoſitions collected from the* Phœnomena *by Induction, are to be deemed, notwithſtanding contrary* Hypotheſes, *either accurately or very nearly true, till other* Phœnomena *occur, by which they may be rendered either more accurate or liable to Exceptions.* *Newton*'s 4th Rule of Philoſ. Pr. Math.

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By JAMES JOHNSTONE, M. D.

TO

THE RIGHT HONOURABLE

GEORGE

LORD *LYTTELTON*,

THIS ESSAY,

IN TESTIMONY

OF

THE MOST SINCERE ESTEEM

AND VENERATION,

IS

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Advertiſement.

THE firſt ſketches of this Eſſay were ſeveral years ſince put into the hands of Dr. LYTTELTON, the late worthy Biſhop of CARLISLE, and Preſident of the Antiquarian Society; who, with all the qualities that endeared the Friend and adorned the Gentleman, had that affection to learning and ſcience, which ſeems congenial to his family.

HIS Lordſhip preſented to the Royal Society that Paper and a Supplement to it; and they are publiſhed in the 54th and 57th volumes of the *Philoſophical Tranſactions*. If they appear in this republication with any new advantages, they are owing to the friendly and candid remarks of very diſtinguiſhed judges of this ſubject;

which, however, appearing inſufficient to overturn this theory, led me to make ſuch additions and to try ſuch experiments, as ſeem to clear up the objections made to it, and illuſtrate and enforce the principal doctrine with ſo much preponderance of argument and evidence, as will probably entitle it hereafter to conſideration in the phyſiology of the nerves, and involuntary motions of animals; and may encourage ſtudents in anatomy to ſupply my deficiences, and become improvers of this ſubject, and in the nervous ſyſtem at large; which is every where an open and inviting field for inventive Genius.

No one can be more ſenſible than I am, that with very inadequate qualifications, I have undertaken a moſt difficult taſk. The utmoſt I flatter myſelf to have done, is to have ſtumbled upon a Path which may be beaten by others to the inſtruction and advantage of mankind. In this hope I ſubmit this Eſſay to the Publick, and I believe take a farewell of this ſubject, in the perſuaſion and words of SENECA, "multum adhuc "reſtat operis, multumque reſtabit; "nec ulli nato poſt mille ſecula præ-"cludetur occaſio aliquid adhuc ad-"jiciendi."

ERRATA.

Page 27 line 5 Volitition—read—Volition.
——73 line 4 are—read—ſeem.
——85 note (n) this—read—This is a truth.
——88 as *He* is—read—*HE* is.
——91 line 14 wiſom—read—wiſdom.

THE

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An

An ESSAY
ON THE
USE OF THE
GANGLIONS of the NERVES.

SECTION I.

The uſe of the Ganglions of the nerves not hitherto aſcertained: Introductory Propoſitions concerning the nerves in general.

SECT. I.

THE Ganglions of the intercoſtal, or, great Sympathetic Nerves, deſcribed by FALLOPIUS (*a*), are oblong, and, very hard knotty bodies; the uſes of which, have not been ſatiſ-

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(*a*) The word Ganglion, is a Greek root, found in CELSUS, and GALEN, and preſerved in modern Books of Surgery; it was at firſt uſed as the name of certain hard Tumors, ſeated on the ligaments or ſinews. The reſemblance of the ganglions of the nerves, real or fancied, to theſe morbid tumors, was probably, factorily aſcertained by any one. From ſome vague reſemblance, which Anatomiſts fancied they found in theſe knots, to thoſe in the roots of ſome Plants and branches of Trees; it was ſuppoſed, their uſe conſiſted in giving ſome additional *firmneſs* to the nerves: but this has not often been repeated, by Anatomical writers after WILLIS and VIEUSSENS. Few Anatomiſts, have indeed

the occaſion, of their being called, by FALLOPIUS, indiſcriminately Ganglia, as well as, corpora olivaria & Plexus. Theſe Terms, and thoſe of conſociation, and, aſſociation, of nerves, were uſed by ſucceeding Anatomiſts, as ſynonymous, till about the beginning of this Century: That, the knots, peculiar to certain nerves, I think, for the moſt part, are, now only, called Ganglia. The other unions of the nerves, without intumeſcence, or hardneſs, are called Plexus; and, in this diſtinct ſenſe, we ſhall uſe theſe words, throughout this Eſſay:

“Corpora olivaria aliquandò concreſcunt, incerto tamen numero, quæ nulla alia *ſubſtantia* quam *nervea* & quaſi in *callum* concreſcente conſtant.—Cum ego primus talem nervorum copulam obſervarim, primus quoque nomine impoſito plexum appellabo a quo plexu plures nervi ad cordis baſim feruntur.” FALLOP. Obſ. Anat. edit. cum oper. VESAL. p. 737. The ingenious Dr. MARTIN concurs with VESALIUS, in diminiſhing the pretenſions of FALLOPIUS as the firſt diſcoverer of the ganglions of the nerves, and in giving that honour to GALEN. *See* Comment. in EUST. Tab. p. 208.

SECT. I.

deed examined this Subject, with that attention and accuracy, with which it is diſcuſſed, by the learned J. M. LANCISI. He imagined the Ganglions, to be muſcles *ſui generis*, and, like other muſcles, capable of contractions; by which he thought, the nervous ſpirits were accelerated and impelled with ſuch additional forces, as are by him, ſuppoſed neceſſary to the production of motions in muſcles ſubject to the Will: And, in order to give an Idea of the ſtructure of all other Ganglia, he particularly deſcribes, and delineates, that of the firſt cervical Ganglion. (*b*)

THIS Theory has the misfortune to be erroneous in its foundation; for that moſt accurate and ſkilfull Inquirer into ſubjects of this nature, the illuſtrious Baron HALLER, and other celebrated Anatomiſts, have not been able to

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(*b*) *See* LANCISI's Diſſertation publiſhed in the Adverſaria Anatomica of MORGAGNI.

SECT. I. diſcover this muſcular apparatus in the *firſt cervical Ganglion* (*c*) or in any other *Ganglion.* The coverings and ſubſtance of Ganglia, with the appearance, have all the firmneſs of ligamentous ſubſtance, but are incapable of that extention and contraction which *muſcular fibres, ever elaſtic,* always allow of.

GANGLIONS beſides, inſtead of being inſtruments ſubſervient to the Will, are almoſt peculiar to nerves, diſtributed to parts, the motions of which are totally involuntary. And our Author muſt indeed have been greatly miſled by his Hypotheſis not to obſerve this ſtriking circumſtance. The Theory, which prevailed in his time and country, of the action of the Dura mater upon the Brain, now exploded, might lead this great Man more entirely to believe an analogous muſcular power in Ganglions.

But

(*c*) HALLER's Elem. Phyſiol. Human. Tom. iv. p. 203.

But the Brain needs no muſcular force to impreſs motion upon the animal ſpirits; *the power preſiding there, is of a different kind:* Nor, granting Ganglions to be, as is ingeniouſly conjectured by LANCISI and WINSLOW, ſubſidiary Brains, or analogous to the Brain in their uſes, will they need any ſuch muſcular apparatus and force. A Power, in fine, abſurd no leſs than imaginary, as it ſuppoſes the force of muſcles of the greateſt exertion and effect, to be derived from thoſe of leaſt bulk and ſtrength: (which muſt, cæteris paribus, be in proportion to the quantity of act muſcular fibres), and would be a ſingle inſtance of a mechanical force producing another infinitely greater than itſelf.

THE accurate WINSLOW, reckons the Ganglions, eſpecially thoſe of the ſpinal nerves, to be ſo many diſperſed origins of the great ſympathetic nerves; but

SECT. I. but goes no farther in pointing out their uſe. The late Profeſſor MONRO, in his excellent Treatiſe upon the nerves, and the illuſtrious Baron HALLER, in his great Work, in which he gives a complete view of every thing that relates to the phyſiology of the Human Body, with moſt other Anatomiſts, eſteem the uſes of the Ganglions abſolutely unknown.

BEFORE I proceed to examine into the uſes of Ganglia, it will be proper to premiſe, as firſt Principles, the following Propoſitions concerning the nervous ſyſtem, which are demonſtrated by Anatomiſts and Phyſiologiſts.

1. THE Brain conſiſts of a glandular ſubſtance of a cineritious color, and abounding with blood veſſels, called its cortical ſubſtance: The medullary part of the Brain, ariſes from the cineritious, and

and the nerves from the medullary ſubſtance; of which they are prolongations.

2. EVERY Nerve is, properly ſpeaking, a bundle of ſmaller nerves, or cylindrical threads; all of which run parallel to each other, without confuſion (except perhaps in Ganglions) from the Brain to their terminations; every funicle of which a nerve conſiſts, has its membranous coat, continued from the Pia mater.

3. THE funicles (2) which to the unaſſiſted eye ſeem ſingle, and to compoſe a nerve, with the help of a Microſcope, are found made up of innumerable ſmaller filaments.

4. THESE nervous filaments or threads, derived from the medullary part of the Brain; convey impreſſions or ſenſations to

SECT. I.

to the Soul, or ſentient Principle ſeated there.

5. Undoubted Experiments demonſtrate that the Power of voluntary motion is derived from the Brain, by the nerves, to the muſcles of the part moved. By experiments we endeavour to imitate or illuſtrate this; thus, if the Brain, or any nerve iſſuing from it, be ſtimulated by any irritating cauſe, the parts whoſe nerves are irritated, whether in the Brain, or lower down, will always be convulſed. And ligatures upon nerves, with no leſs certainty intercept the efficacy of this irritation above them, than they render the parts paralytic or immoveable by the Will.

6. BUT this power or cauſe which is conveyed by nerves, and puts muſcles in action, is not inſtantly loſt in nerves,

when their communication with the Brain is interrupted by cutting the nerve aſunder, or tying a tight ligature upon it. For if the nerve be irritated below, or betwixt the ſection or the ligature, and the muſcle it goes to; the muſcle is convulſed as effectually, as if the communication with the Brain had not been cut off. Thus, after the Head is cut off, irritations of the ſpinal marrow convulſe the trunk of the Body and limbs entirely: In like manner irritations of particular nerves, the *Phrenic* for example, after the deſtruction of the ſpinal marrow, throw the Diaphragm into convulſive contractions: Thus the muſcles of the head, eyes, and tongue are convulſed by probes thruſt into the brain, when the head is ſeparated from the body: And thus, the Heart itſelf is made to contract, after it is ſeparated from the body. So that it is evident, that, tho' in a general view and ultimately, the nerves and muſcles depend upon the brain for their fluid, or whatever is the cauſe of their energy, yet, that dependance is by no means ſo immediate, but that effects may be produced by and in nerves and muſcles ſeparated from the brain, through that remaining ſtock of energy, ſometime before derived from it, and not ſo ſuddenly diſſipated and exhauſted, as ſome Theories would incline us to believe.

Hence alſo we may conclude, that it is not certain that Irritability is ſo entirely a diſtinct property of muſcular fibres, as to be totally independent of the nerves; as no experiment can be contrived, in which muſcular fibres can be perfectly ſeparated from the nervous web, intermixed with, and diffuſed a-

SECT. I.

mong them; and to which the contraction of muſcles irritated after ſeparation from the Body, may be owing in a great meaſure.

On ſçait que les *Plexus* ſont formés de l'entrelacement d'une Multitude de Nerfs. Il y a de ces Plexus dans differentes Régions du Corps. Et comme il y a plus de Sentiment, là où il y a plus de Nerfs raſſemblés, le Sentiment est très vif dans ces *Plexus*. leur Communication avec le Cerveau etablit entr'eux & lui une Réciprocité d'Action. Different Nerfs ſe recontrent dans une Point commun. Ils y forment un *Nœud*. Les Anatomistes nomment ce Nœud un *Ganglion*. Le Sentiment est auſſi très vif dans ces *Ganglions*. Ils ſont des Especes de petits Cerveaux. Il n'est Personne qui n'ait éprouvé dans de grand Mouvemens de l'Ame, une ſorte de preſſion, ou de Commotion, dans la Région de l'Estomac. Les *Ganglions* qui occupent cette Région, ſont le Siege de ce Sentiment. Leur Jeu repond à lui de la Paſſion. ſont liés avec le Cerveau qui en est alors le Moteur, & 'ils meuvent a leur Tour."

Eſsai Anal: sur l'Ame V.1. c.XVIII. p.292.

SECTION II.

Seat and genuine uſe of Ganglions.

SECT. II. 1. GANGLIONS are obſerved to be ſeated generally upon nervous cords, formed by the union of ſeveral different nerves; and ſometimes too before nervous cords ſend off branches.

ALL of them except the ophthalmic ganglion, (and two or three beſides, belonging to the fifth pair not conſtantly found) either are ſeated upon the great ſympathetic nerves, or are, as we ſhall experimentally ſhew hereafter, to be conſidered as their origins.

SECT. II.

2. THEY appear to abound with blood veſſels; and it is obſerved by M. DE HALLER, that the nervous filaments loſe in ganglions, their rectilineal parallel direction (No. 2. above) and ſeem to be intimately commixed therein (*d*).

3. THE bulk of a Ganglion conſtantly exceeds that of all the veſſels and nerves which it receives, and of which it may ſeem compoſed (*e*). Hence we may

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(*d*) This was already obſerved by GLISSON, who calls the ordinary unions of the nerves *Aſſociationes*, and thoſe now called Ganglions, he calls *Plexus*. "Inter aſſociationes haſce & plexus id diſcriminis eſt, quod illæ *fibras ſuas peculiares magis diſtinctas, minuſq; invicem implicatas* ſervent; quod etiam *nodis* ut plurimum careant." GLISSON, de Anatome Hepatis.

This is confirmed by the Authority of Baron HALLER, In Ganglio involucrum ex dura celluloſa tela eſt, ſive Vagina Rubens firma, ipſique etiam funiculi nervei interrumpuntur, ut fibrarum porro rectarum parallelum ductum, non diſtinguas, videanturque ii funiculi intime commiſceri. HALLER Elem. Ph. T. iv. p. 203,—Prim. Lin. No. 377.

(*e*) Gangliorum moles major eſt quam ſit aggregatum omnium vaſorum ingredientium atque egredientium; quo fit, ut ad eorum productionem, neceſſe ſit concurrere, præter communia vaſa, *peculiare aliud corpus*, non tam ex cohærentia & complicatione præfatorum nervorum, ac ſanguiferorum, *quam ex novis organicis partibus*

SECT. II.

may reaſonably conclude, that in Ganglions the different nervous filaments are very intimately mixed; that a new nervous organization, or arrangement of the medullary ſubſtance probably takes place in them, and is ſubſervient to ſome important purpoſe in the animal Machine; a conjecture which has the ſanction of a WINSLOW, and the lateſt as well as the earlier thoughts of the great MORGAGNI in its favour, *(f)* tho' that purpoſe is not pointed out by them.

In order to determine the particular uſe of Ganglions, (the intimate ſtructure

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tibus quas provida ſolerſque natura, ſubſiſtentibus probeque excoctis liquidis, ſimul etiam elongatis varieque diſpoſitis ſolidorum fibris, fingat & creat. LANCIS. de Gangl.

Certum eſt, ganglia conſtanter majora eſſe, & nonnunquam inſigniſſime majora quam nervus eſt ex quo quodque oritur. Certum eſt etiam, nervos ex gangliis fere ſemper numeroſiores prodire quam ſubierunt. HALLER, ib.

(f) See MORGAGNI Adverſar Anatom. T. ii. p. 71. & ejuſdem de Sedibus & Cauſis Morb. Epiſt. 12. Art. 14. Ces ganglions ſont compoſe's d'un melange de Subſtance Moelleuſe, & de ſubſtance cendree, arroſe de pluſieurs petits vaiſſeaux Sanguins. Traite' de la Teſte. 629. WINSLOW.—See alſo his Expoſition Anatomique', p. 462. 4to.—and following quotation;

ture of which, equally with that of the Brain, and medullary ſubſtance of the nerves, we are hitherto ignorant of) in the animal ſyſtem; let us try if ſomething tending this way may not be ſuggeſted, by reflecting on the functions and motions of the parts ſupplied principally by nervous cords from below the Ganglions.

THE intercoſtal, more fitly called the great Sympathetick nerves, abound moſt with Ganglions (*g*); and by examining

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(*g*) Ces nerfs communement appelle's Intercoſtaux "Dans "toute leur etendue, ils repreſentent deux cordons, deviſe's & "comme entrecoupe's d'eſpace en eſpace par un grand nombre "de petites tumeurs ganglioformes, moyennant leſquelles ils "communiquent en arriere par deux fillets collateraux fort courts, "& produiſſent en devant toutes leurs ramifications particulieres.

"Ces tumeurs ganglioformes, ou Ganglions, different plus ou "moins en Volume, en couleur & en conſiſtence; & on les "peut regarder comme autant *d'origines ou des Germs* diſperſes "de cette grande paire des nerfs *ſympathiques*, & par conſequent "comme autant *des petits Cerveaux*." WINSLOW Expos. Anatom. p. 462. 4to. edit.

Super omnes nervos, intercoſtali, Ganglia ſunt frequentiſſima, in cervice quidem tria; in thorace, lumbis, & pelvi tot, quot nervorum

SECT. II. amining what is particular and peculiar in the motions of Parts to which theſe nerves are diſtributed, we ſhall probably be led to the uſes of Ganglions.

THE muſcular ſubſtance of the heart, has its principal, or rather all its nerves, from the intercoſtals; which are always detached from the principal cords, below the Ganglions, and chiefly from the inferior cervical Ganglion. The few nervous cords from the Par Vagum, or eighth pair, which in the human ſubject, are ſent towards the heart, are almoſt totally ſpread upon the Pericardium and great veſſels (*b*).

IN the Abdomen, this nerve unites with the Par Vagum of the right ſide

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nervorum ex ſpinali medulla propagines intercoſtalis accepit: tum in cordis vicinia, ſub diaphragmate, circa Arteriæ cæliacæ & meſentericæ originem, & circa renem paſſim in plexuoſis retibus. HALLER El. Phyſ. T. iv. p. 202.

(*b*) Ibid T. i. p. 366.

ſide (*i*), and they together form the great ſemilunar Ganglion; from which, and from other Ganglions formed in inferior parts of the abdomen, filaments are diſtributed to the Inteſtines, the Liver, the Spleen, the Kidneys; and ſome of them deſcend to the Fallopian Tubes, Uterus, and other parts in the Pelvis; ſome of which are alſo in part furniſhed with filaments from the lumbar nerves.

SECT. II.

THE Heart and Inteſtines, being wholly ſupplied by nervous filaments detached below ſome remarkable Ganglion, we muſt enquire what is peculiar in the motions of theſe parts, or in their ſtructure: But the motions of the Heart and Inteſtines are remarkable, and exactly ſimilar, in being both involun-

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(*i*) WINSLOW Traite des nerfs, No. 141.——The reader is alſo deſired carefully to examine the 23 Table of VIEUSSENS' neurographia, which repreſents the courſe of the great ſympathetic nerves with their ganglions and connections.

SECT. II.

tary, or not liable to be either ſtopt, renewed, or in any way controuled by the Will.

THOUGH it be very certain, that theſe motions are excited in the heart by the gentle ſtimulus of the Blood upon the internal ſurface of that organ; and in the inteſtines by that of the ſecreted liquors, and of the food taken in; of which ſtimuli, theſe parts have the quickeſt and moſt exquiſite perception; yet this being ordinarily not ſo ſtrong, as to make us conſcious of its action, much leſs painfully ſo, can hardly be ſuppoſed to render theſe motions quite uncontroulable by the Will, without ſome other efficient cauſe (*k*).

(*k*) In an excellent explanation of the *vital and involuntary motions of animals,* by a learned profeſſor and ingenious writer, in whoſe death the medical world has ſuſtained an irreparable loſs, it is remarked with the acuteneſs proper to this excellent author; "I imagine, that the mind's *want of power* over the motion of "the Heart, is not only owing to its being continually acted "upon

SECT. II.

ANATOMY diſcovers no peculiarity in the muſcular ſtructure of theſe parts likely to account for this, and excepting in their nerves having Ganglions, which ſeem indeed almoſt appropriated to them, no anatomical difference has been obſerved, no mechaniſm, which theſe parts have, more than thoſe muſcles which are ſubject to the direction of the Will.

MAY we not then reaſonably conclude, that Ganglions are the Inſtruments, by which the motions of the Heart and Inteſtines are from the *earlieſt* to the *lateſt periods* of animal life, *rendered uniformly involuntary*; and that this *is their uſe?* which they ſubſerve by a ſtructure indeed unknown to us

(yet

"upon by a ſtimulus, *but in part to an original conſtitution*; and "that tho' we ſhould ſuppoſe this organ for a little while free "from every degree of irritation, yet the mind by an effort of "the will could not move it." WHYTT's Eſſay on the vital and involuntary motions of Animals, p. 316. I hope in this Eſſay to point out the *Conſtitution*, here ingenuouſly hinted at.

SECT. II.

(yet evidently different from that which uſually obtains in nerves), no leſs than that of the Brain, tho' it ſeems not improbable, the firſt may have ſome analogy to the laſt.

THIS Concluſion concerning the uſe of Ganglions, is ſupported by every truly parallel inſtance. Thus the motions of the *Uvea*, or *muſcular circle of the Pupil* of the Eye, ever contracted or dilated, as the Eye is more or leſs irradiated with light (*l*), are as much *involuntary*, as thoſe of the Heart itſelf; though ſome unneceſſary diſtinctions have been made concerning them, of which we ſhall afterwards take notice; and it is known to Anatomiſts, that the muſcular fibres of the Uvea are ſupplied by nerves from the *lenticular Ganglion*, which ſeems formed ſolely

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(*l*) Dilatation is the *Reſt* or natural State of the Pupil, as Contraction is its *Action*. It dilates in an obſcure light and when the Eye is directed to diſtant objects, and contracts when directed to near objects, and when a brighter light ſtrikes upon the Retina.

ſolely for the uſe of that muſcle, and for that purpoſe (*m*).

SECT. II.

WHEN we conſider that the nerves, which are more immediately miniſterial to the Soul (*n*), and convey impreſſions of external objects to it, have no Ganglions: that they are never found upon the Olfactory, Optic, or Auditory nerves and that they are as rare upon the

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(*m*) See WINSLOW's deſcription of this Ganglion, Traite' des nerfs, No. 22, 23, 24. It is known by the Synonymous names of Ganglion lenticulare, Ciliare, and Ophthalmicum: the following is Baron HALLER's accurate deſcription of it, "Tertii Paris "ramus, vel reliquus truncus, eſt radix præcipua craſſa breviſque "ganglii, eademque extrorſum incedit, inque nervo optico, ſub "muſculo abductore, efficit *Ganglion ciliare* ſive ophthalmicum "ovale, *perpetuum,* perminutum. Eſt ubi id a ſolo tertio naſcitur, "*neque deeſſe unquam vidi,* neque duo, aut plura fuiſſe, ut nuperi "aliqui habent:——Nervi quinti paris ramus primus ophthalmicus "dictus, edit ramum, euntem in Ganglion ciliare, *Ex eo ganglio* "*ſurculi tendunt in uveam,* fibrarumque radiatarum partem aliquam "ſed exiguam faciunt." HALLER Elem. Phyſ. p. 427—429.

(*n*) Nervos qui ſenſibus ancillantur, ut olfactorios, opticos, auditorios, alioſque nullis Gangliis munitos eſſe. Sunt enim ſenſus in corpore quaſi quædam viæ ut Tullius ait, ad oculos ad aures ad nares a ſede animi perforatæ; nulla idcirco in iis aut repagula, aut incitamenta addenda, vel interponenda erant. J. MAR. LANCIS in Diſſert. citat.

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the nerves inſtrumental in voluntary motion, as they are conſtant and numerous in parts whoſe motions are independent of our Volitions; we have in this caſe the firmeſt grounds of belief, that Ganglia, on the latter, are placed as checks to the powers of Volition, and that the former are exempted from them, becauſe they would have interrupted and prevented the determinations of the Will, from reaching the parts intended to be ſubject to it, and upon ſenſory nerves, would have rendered the notices we receive much leſs diſtinct perfect and acute than they ought to be.

THE left nerve of the eighth pair, diſtributed to the Stomach, and probably the cauſe of the diſtinct and exquiſite ſenſation of that organ, and of its remarkable ſympathy with the Head, ſeems alſo principally concerned in tranſmitting

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mitting the ſenſe of hunger to the mind, and therefore may be conſidered as a ſenſory nerve. This notion ſeems proved by, and in its turn throws light upon, thoſe Experiments made by the moſt celebrated Anatomiſts, in which the eighth pair of nerves was cut aſunder or tied in Brutes, and by which the functions of the Stomach were moſt manifeſtly diſordered (*o*). The lateſt and beſt Anatomiſts agree there is no Ganglion found on this nerve, between its origin and the Stomach, where it is chiefly ſpent (*p*).

IF Ganglions were not intended to check, and did not actually limit the powers of Volition; the Diaphragm had

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(*o*) “ Nervo Octavi Paris diſſecto, Vox ſublata eſt, & reſpiratio “ facta gravior, & *concoctio ciborum deſtructa*, & *cibus in Ventri-* “ *culum non venit.*” MORGAGNI in Comm. Bonon. & de Cauſis & Sedib. Morb.

“ Nervo Octavi Paris ligato, reſpiratio difficilis, vox ſublata “ eſt, *ciborum borror*, vomitus, ventriculus fœcibus pleniſſimus, “ demum

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had probably been entirely furniſhed from the Intercoſtals, as moſt of the parts in the Thorax above it, and in the Abdomen below it, are. But as the motions of this muſcular membrane were to be controulable by the Will, we find peculiar nerves, namely, the Phrenic, which are deſtitute of Ganglions, ſent to it from a great diſtance.

" demum cibi omnino in Ventriculo ita corrupti, ut ſolent craſſis " in inteſtinis eſſe." BRUNNERI nepot. Exp. in HALLER Elem. Phyſ. Tom. iv. p. 324.

(*p*) " Nervi anaſtomoſes inter ſe ut vaſa, frequentes faciunt, " & in concurſu ramorum ex diverſis truncis ortorum imprimis " Ganglia reperiuntur. In ſenſoriis unice nervis non reperiuntur, " & *nulla ſunt Octavo*, Phrenico, nervis artuum." A. van " HALLER Prim. Lin. Phyſ. No. 377.

SECTION III.

Anatomical Objections ſtated, and anſwered: our doctrine ſupported by Experiments.

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THUS far have I ſtated the facts and arguments which tend directly to prove the doctrine I have advanced concerning the uſes of Ganglions. And though I am ſenſible, they may not have ſuch force, and far leſs ſuch advantage of arrangement, and of authority, as to compel conviction, and are rather likely to ſatisfy thoſe, who, laying aſide prejudices of various kinds, are candidly diſpoſed to give Truth that peaceful reception which it ſo ſeldom has met with, than to ſtand the rigorous teſt of a captious Controverſy:

SECT. III. I am, notwithſtanding, perſuaded that my main concluſion will be found to have a conſiderable weight of probability, yea, evidence in its favour, when weighed againſt thoſe objections which may be brought againſt it, and thoſe difficulties from which I am conſcious it is not exempt. Theſe however are chiefly ſuch as ariſe from our imperfect knowledge of the nervous Syſtem; a terra incognita, which remains to immortalize the name of ſome future diſcoverer in Anatomy.

IT is well known, for inſtance, and it is almoſt the only objection of any weight, to which our doctrine is liable, "That all the nerves ſent from the "ſpinal marrow, have Ganglions where "they ſend off the filaments which "communicate with the Intercoſtals (*q*)." The concurrence of Facts in favour of our

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(*q*) VIEUSSENS Neurogr. Tab. 23.

our doctrine, render'd it highly probable that theſe Ganglions reſpected excluſively the great ſympathetic nerves, and that they were the firſt checks to the uſual powers of Volitition, and affected only the filaments ſent to the ſympathetic nerves, leaving the other nervous filaments of the ſpinal nerves fit, and free for the conveyance of the commands of the Will, as in fact, they are chiefly diſtributed to muſcles under its power and direction; but it did not till lately occur to me that this might be determined and proved one way or other by experiments.

IT is allowed by Phyſiologiſts, that when any nerve is irritated, the muſcle it goes to, or if it is a large nerve, or bundle of nerves, all the muſcles ſupplied from them, are by that irritation violently convulſed. (See Prop. 5—6. § I.

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IF then, it ſhall appear, that irritations and injuries of the ſpinal marrow (from which the intercoſtal, or great ſympathetic nerves which ſupply the Heart and Inteſtines truely ariſe, as well as thoſe nerves diſtributed to the limbs), occaſion violent convulſions of the limbs, and yet, do not in the leaſt affect the Heart and Inteſtines, parts the moſt irritable of any in the Body; as will indeed be manifeſt by the following experiments: the difference will probably be accounted for from the intervention of Ganglion after Ganglion, conſtantly found betwixt the ſpinal marrow and the heart and inteſtines: The ſubtilty of experiments in determining what no Microſcope or anatomical knife would detect and aſcertain, will be acknowledged, and the unprejudiced inquirer into nature, will perhaps be led to aſcribe thoſe uſes to Ganglions which I have done.

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I. ON the 4th of *March* 1767, a Kitten a week old had its head cut off betwixt the firſt and ſecond vertebræ of the neck: The Thorax was opened with all expedition, and the heart laid bare to view, and obſerved for ſome time, that any difference might be more certainly noticed: After the Animal ceaſed to move its limbs, I touched the ſpinal marrow with a probe, immediately the extremities of the animal were all ſtrongly convulſed, but the heart alone, ſeemed unaffected, and continued to move without acceleration, or any degree of alteration whatſoever (*r*).

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(*r*) Convulſiones totius Animalis, "ab irritata medulla ſpinali " natæ, cordis motum non ſuſcitant." HALLER Elem. Phyſ. T. ii. p. 205.

Theſe experiments were tried, and their events as here related obſerved, long after the firſt draught of this Eſſay had been ſent to the Royal Society. I therefore appeal to ſuch Perſons as may chuſe to repeat them, diſagreeable as they are, whether I miſrepreſent them through prejudice, or not.

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BETWIXT this time and *April* 10, I repeated the ſame experiment upon half a dozen Kittens ſtill younger than the firſt; upon opening the thorax the heart beat at leaſt ſeventy ſtrokes in a minute.

WHEN the heart beat only forty in a minute, or thereabouts, I began gently to touch the ſpinal marrow with the point of a probe, and the limbs were immediately convulſed, but the heart not in the leaſt affected.

I SLIT open both the ventricles of the heart, ſo as to let out all the blood they contained, and inſtantly the heart ceaſed to beat (though before the blood is thus removed, its pulſation continues very long in Animals ſo young, eſpecially of this kind), but the auricles which were not opened, and therefore were ſtill ſtimulated by the blood, beat on.

AFTER this preparation in ſeveral of theſe Animals, I thruſt the probe into the ſpinal marrow, but the heart nevertheleſs continued in perfect reſt and inaction; though when its ſubſtance was pricked with the point of a knife, it might ſtill be made to contract.

BUT though the heart and inteſtines remained equally unaffected in all the trials I made, by thruſting the probe into the ſpinal marrow, the following Convulſions occaſioned by it deſerve particular Enumeration.

ALL the limbs were violently convulſed.

THE muſcles of the back were convulſed, and the ſpine bent as in the Opiſthotonos.

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THE intercoſtal muſcles were all contracted, and their natural action, that of drawing all the Ribs nearer each other and upwards, was rendered a matter of occular demonſtration.

THE Diaphragm was contracted ſtrongly, notwithſtanding the Phrenic nerve of one ſide, was divided, in making ſimilar experiments by pricking and ſtretching it; which, by the way, conſtantly occaſioned a convulſive contraction of the Diaphragm.

EVEN by plunging the probe into the Brain, after the head had been cut off ſome minutes, the Eyes, Tongue, and lower Jaw were made to move. (*ſ*).

I HAVE

(*ſ*) In an account of the Execution of *Mary* Queen of *Scots*, it is declared that her Lips ſtirred up and down almoſt a quarter of an hour after her head was cut off. BALLARD's Memoirs of learned ladies of *Great Britain*, p. 166.

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I HAVE made the ſame experiments, with like conſequences upon Frogs.

BUT theſe experiments muſt be made within leſs than a quarter of an hour after decapitation; half an hour after, no ſuch effects follow the deſtruction of the ſpinal marrow. And they ſucceed beſt by previouſly opening the ventricles of the heart: By the way, the irritability of the muſcles continues not longer than the power of exciting contractions in them by irritating the correſponding nerves.

EXPERIMENTS, ſimilar to theſe in event, have been made on Frogs, by STUART, Bar. HALLER, Dr. WHYTT, and many more.

" WHEN I opened (ſays the laſt
" of this ingenious Triumvirate) the
" Thorax of a Frog, immediately af-

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" ter decollation, and deſtroying its " ſpinal marrow, I obſerved its heart " beating after the rate of ſixty in a " minute, which is four or five pulſa- " tions leſs than I have generally ſeen " the hearts of Frogs make in that " time, when the Thorax was opened " without decollation (*t*)."

II. " SOME young Gentlemen, hav- " ing hanged a Cat, till ſhe was quite " dead, opened the Thorax and ob- " ſerved only a tremulous motion in " the heart, which ſoon ceaſed, but " was renewed by pricking it with " a ſharp inſtrument: after this by " ſqueezing the Cardiac nerves down- " wards, or otherwiſe irritating them, " the heart was made to perform two " or three pulſations, which it conti- " nued to do for a conſiderable time,

" when-

(*t*) See WHYTT's Exp. on living and dying Animals, Eſſ. Ph. and Lit. 2 Vol. p. 282. and WHYTT's Phyſical Eſſays.

" whenever the Cardiac nerves were " thus ſtimulated (*v*)." Theſe Experiments were made with no kind of view to the doctrine which I ſhall endeavour to ſhew they enforce and ſupport.

III. ANIMALS are killed, ſome ſooner, and others, eſpecially of the cold kind (as Frogs and Tortoiſes, on account of the largeneſs of the ſpinal marrow) much later, by cutting through the ſpinal marrow near its origin. The cutting thro' the intercoſtal nerves, or the tying ligatures upon them, is alſo ſooner or later *fatal* to the Animals the experiments have been tried upon, by finally deſtroying the *Heart's motion*, and inſtantly, in a wonderful manner, *weakening and diſturbing its motions* (*w*).

(*v*) Eſſay on the vital and involuntary motions of Animals, by WHYTT, p. 355.

(*w*) Octavæ conjugationis nervis, una cum nervis par intercoſtale conſtituentibus, circa cervicem, ex tranſverſo reciſis, animal

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These Experiments prove, that the Ganglions on the ſpinal nerves, do not hinder the irritation of the ſpinal marrow from cauſing convulſions in the voluntary muſcles: And that the Ganglions (1) do, in all probability, hinder that cauſe from acting (as without their intervention it muſt have done) upon the heart, by means of its nerves, chiefly ariſing from the ſpinal marrow originally: And therefore it ſeems evident, and beyond a plauſible conjecture, that the Ganglions on the ſpinal nerves, relate excluſively and ſolely to the intercoſtal

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mal illico languore futuræ mortis prænuncio afficitur, *tremulos motus patitur*, vires illius ſenſim labaſcunt, & intra 24 circiter horas, vita deſtituitur, quæ per illud breve temporis ſpatium, ſpiritu animali ſuſtinetur, quem medulla ſpinalis, & nervei plexus intra medium & infimum ventrem latitantes naturalibus & vitalibus partibus ſuppeditant. Vieuſſens neurographia, cap. iv. Lower de Corde. Haller, Elem. P. T. i. p. 464—5. And Morgagni de Sedibus Morb. Ep. xix. art. 23. deſcribes the encheireſis, or manner of making this experiment, and obſerves, it is impoſſible in Brutes to cut or tye the Intercoſtal nerves or par vagum, ſeparately, without dividing or tying both together; a fact, which has not been always conſidered in reaſoning upon this experiment.

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coſtal or great ſympathetic nerves, for the purpoſes I have endeavoured to prove: This doctrine derives farther confirmation from experiment (2), as we thereby ſee that the heart may be made to move, as all other muſcles may, by irritating or ſqueezing its proper nerves, below their Ganglions: And, that the motions of the heart cannot long continue, in warm animals eſpecially, after the diviſion of their principal nerves (3), which ſhews the dependance of the heart (*Prelim. Prop.* 6) ultimately, as that of all other muſcles, upon its proper nerves, and their connection with the Brain.

It is objected, "That one or two
" Ganglions, are often obſerved upon
" a filament of the ſecond great branch,
" and another upon the third branch of
" the fifth pair of nerves."

THE

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THE conſtancy, and if, I may ſo expreſs it, the ſolicitude with which all parts whoſe motions are involuntary, are provided with nerves, furniſhed and beſet with Ganglions; and the great ſcarcity of them on nerves detached to muſcles ſubject to our Volitions, and the total want of them, on the ſenſory nerves, ſufficiently beſpeaks their general deſtination and uſe; notwithſtanding a few ſeeming exceptions: ſeeming I ſay, becauſe thoſe few alledged as ſuch, are not permanent parts of animal ſtructure, or conſtantly found. As their appearance is in ſome meaſure accidental, we have reaſon to ſuſpect them to be rather morbid Phænomena, than organs of great importance in the animal ſyſtem: The Ganglia in particular of MEKELIUS, found on the ſecond and third branches of the fifth pair of nerves, are very eſſentially diſtinguiſhed by Baron HALLER from other Ganglions;

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lions; particularly the Ganglion Ophthalmicum, which he ſays is conſtant and perpetual; whereas the other Ganglions of the fifth pair are not ſo, for he remembers to have examined Bodies, in which they were wanting (*x*). But ſuppoſing the utmoſt in favour of the conſtancy of theſe Ganglia of the fifth pair; the nervous twigs on which they have been obſerved, being chiefly diſtributed to the ſalivary and mucous Glands, about the jaws, tongue, palate, throat, and noſtrils; may they not be ſuppoſed to have ſome uſe in glandular ſecretion? For we ſee the glandular parts in the Abdomen, are ſupplied by the

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(*x*) Theſe Ganglions have been ſeen on a twig of the ſupermaxillary branch of the fifth pair, with reſpect to which Baron HALLER ſays, "Memini in aliis Cadaveribus eodem loco nullum "adfuiſſe." El. Ph. T. iv. p. 213. The ſame he obſerves with reſpect to another Ganglion, ſometimes ſeen on the lingual Branch of the third great Branch of the fifth pair, the maxillaris inferior, it was ſometimes not found. Ibid. T. iv. p. 218—219. The Pterygoid Branch on which a third Ganglion has been ſeen, ſends one or two twigs to unite with the intercoſtal nerves at its origin.

SECT. III. the great ſympathetic nerves, as well as the muſcular fibres of the heart and inteſtines.

IT has likewiſe been objected, "That "the great ſympathetic nerves ſend "ſome branches to parts, under the "controul of the Will, as the Pharynx "and Diaphragm, as well as to the "heart and inteſtines, not ſubject to "that controul."

IT is well known that tho' the Pharynx derives ſome nerves from the great ſympathetic nerves; its moſt conſiderable ſupply of nerves comes from the eighth pair: and the Diaphragm is rendered paralytic by tying or cutting the Phrenic nerves diſtributed to it; which ſhews that its motions have very little dependance on the minute filaments which it receives from the great ſympathetic nerves. There are other parts, motions in theſe parts beſides thoſe of the voluntary kind; their motions being of the *mixed* kind, ſometimes being *involuntary*, at others voluntary. There are other parts alſo, as well as theſe now named, whoſe motions are of the mixed kind; and it is remarkable that all of them have two different kinds of nerves; namely, ſome without Ganglions to ſubject them to the powers of Volition; and others that have Ganglions to ſupply the involuntary motions of the ſame parts. Thus the Diaphragm moves, when we are a-ſleep, and when we are awake, though not quite ſo often, and continues to move, tho' leſs frequently, even during a profound Apoplectic Fit. In like manner, we can raiſe the Pharynx by an effort of the Will, yet in the action of Deglutition, its motions are chiefly involuntary from the ſtimulus of the food paſſing down the gul-

SECT. III. let (*y*). In the involuntary motions, the ſtimulus which excites, regulates their intenſeneſs and continuance: In the voluntary motions, the Will excites and regulates them all.

WE are not to imagine, nor do I know that it is generally ſuppoſed by Anatomiſts, that wherever the nerves unite, their medullary ſubſtance either decuſſates, or is ſo intimately mixed, as is reaſonably ſuppoſed to be the caſe in Ganglions, by moſt Anatomiſts, from GLISSON down to HALLER: We know at leaſt, that this is far from being the caſe in the *Optic* nerves; for though they unite, and were ſuppoſed to croſs each other, the contrary appears by Obſervations, made, in the bodies of Perſons who were blind of one eye from a fault of the Optic nerve; the nerve of the

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(*y*) See Eſſay on the Vital and Involuntary motions of Animals.

the affected ſide only being waſted, while the other was large and plump (z). And we may juſtly infer, the *Plexiform unions* of the nerves, diſtributed to the ſuperior and inferior extremities, not to be more intimate, nor intended to ſerve any ſuch purpoſe as Ganglions, ſince theſe nerves are equally motory and ſenſory; no other nerves being diſtributed to the ſkin, the organ of touch, but from the ſub-diviſion of theſe Plexuſes.

(z) See the Anatomy of the nerves in general by a late juſtly celebrated profeſſor of Anatomy, Dr. MONRO, Sen. p. 356. and No. 23. SANTORINI OBS. ANAT. 63. VESALII Anatom. Lib. iv. C. iv. " VESALIUS, AQUAPENDENS, VALVERDA
" aliquando obſervarunt, toto ductu diviſos opticos nervos
" manſiſſe, & eum tamen in quo ſic conſpexit VESALIUS de viſu
" nunquam conqueſtum fuiſſe, viſuque præſtanti ſemper valuiſſe."
" MORGAGNI de ſedib. Morb. Ep. xiii. Art. 7.

SECTION IV.

Phyſiological difficulties obviated: Conjectures concerning Irritability, &c.

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IF theſe Anatomical difficulties do not ſubvert our doctrine, the following of a Phyſiological nature, it is preſumed, will not be more formidable; or perhaps, may become arguments in its favour, when properly conſidered.

IT has been objected, "That if the "Ganglia intercept the communication "between the ſenſorium commune, and "thoſe parts whoſe nerves are derived "from them; they ought not only "to intercept the commands of the

Will,

" Will, and render the motions of " theſe parts not voluntary, but they " ought alſo to prevent the impreſſions " made on the nerves of theſe parts, " from being conveyed to the ſenſorium " commune, *i. e.* theſe parts ought to " be inſenſible: the contrary of which " is true. For example, the Inteſtines, " whoſe nerves come from Ganglia, " are among the moſt ſenſible parts of " the body: and if the uneaſy ſen- " ſation in the Lungs, in Aſthmatic " caſes, was not conveyed to the ſen- " ſorium commune, how could the " Will redouble the action of the Dia- " phragm and the intercoſtal muſcles?"

I. To this it may be anſwered, That an Anaſtomoſis, or new arrangement of the nervous filaments which appears to take place in Ganglia, may intercept the efforts of the Will, and alſo render the ſenſations of parts wholly ſupplied with

SECT. IV. with nerves from Ganglions leſs determinate and preciſe than in other parts, which indeed is a fact; yet, without rendering ſuch parts totally inſenſible. Paralytic Diſeaſes ſhow, that the nerves may be ſo affected, as to be incapable of conveying the commands of the Will, and yet remain ſufficiently capable of reconveying ſenſible perceptions. In the Palſies which are moſt frequent, the parts rendered perfectly immoveable by the diſeaſe, have as quick a feeling as thoſe that are moveable by the Will; and what deſerves attention, are often moved involuntarily, eſpecially upon the application of any painful ſtimulus: and it is obſervable too, that paralytic limbs, which are not to be moved by our Volitions, are often called into action, when the paralytic perſon is ſuddenly thrown into any violent paſſion; juſt as we obſerve the ſame cauſe to produce extraordinary com-

commotions in the Heart and Inteſtines, &c. though the Will, coolly exerted, has no power over theſe parts.

II. VARIOUS obſervators have ſhown that the feelings of the organs, whoſe motions are involuntary, are by no means exact, nor always acute. We have it on the authority of HARVEY (*a*), confirmed by Baron HALLER, that the heart tho' highly irritable, is when touched, very dully ſenſible, as has alſo appeared in wounds and contuſions of this part (*b*). HALLER aſſerts that the lungs, liver, ſpleen, and kidnies, all ſupplied from the great ſympathetic nerves, have been cut in pieces, and yet the animal ſeemed to feel no pain. And (which is a proof leſs liable to exception) operations and diſeaſes in the kidnies, and ulcers in the lungs being but

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(*a*) HARVEII de Generat. Animal.

(*b*) Phil. Trans. Vol. LII.

SECT. IV. but little painful, ſhow the feelings of theſe parts not to be exquiſite (*c*).

III. THE Stomach, which has a very large portion of the eighth pair of nerves beſtowed upon it, loſes its ſenſibility and contractile power ſo perfectly by ligatures of this nerve, that the food neither paſſes down the œſophagus, nor is concocted in the ſtomach, and by ſpontaneous corruption there puts on the appearance of the fæces themſelves ſo fætid in the large inteſtines (*d*). 'Tis, in conſequence of the ſenſibility which the ſtomach derives by means of this nerve, along with its peculiar organization, that the ſtomach becomes the principal ſeat of hunger; and, to uſe the words of a celebrated writer, "As it is "affected with a more diſagreeable "ſenſation, when we have wanted food "for any conſiderable time, than the "guts;

(*c*) HALLER's celebrated Eſſay on ſenſible and irritable parts.

(*d*) See MORGAGNI, & VIEUSSENS locis citatis.

" guts; ſo likewiſe it is more ſenſible " of an agreeable feeling, from grateful food: and in theſe reſpects it " may be ſaid to be *more ſenſible* than " the inteſtines (*e*).

IV. A LESS preciſe feeling the inteſtines certainly have; and tho' in many inſtances they are the ſeat of exquiſite pain, yet in conſequence of the *connexions* of the nervous filaments in the Ganglions, any painful diſeaſe ſeated in the inteſtines, or in the other Viſcera contained in the Abdomen, is by ſenſation leſs determinable to its particular ſeat, or rather is more apt to affect the parts adjoining, than diſeaſes of a painful nature which are ſeated in the ſtomach itſelf, and in other parts whoſe nerves are not ſupplied with Ganglions (*f*).

(*e*) See WHYTT's Path. Eſſays, p. 155. firſt Edit.

(*f*) Ut anima non adeo accurate locum dolentem diſtinguat, ſed obiter utcunque, et aliqua latitudine. A. V. HALLER El. Phyſ. T. iv. p. 407.

SECT. IV. AND this leads us to a natural ſolution of that ſympathy, that *intercommunion of ſenſations, or that imputation of ſenſation*, which ſo frequently takes place in the Cholic, inflammation of the Inteſtines, and nephritic complaints, and other diſeaſes of the contained parts of the Abdomen, from which ſome writers *(g)* have very concluſively argued for the neceſſity of ſuch a communication of the nervous filaments in Ganglions, as appears indeed, to take place in them, and which among other important uſes, ſeems the occaſion of many of thoſe ſympathetic ſenſations in the lower belly ſo frequently taken notice of, and ſo difficult to be explained (*h*).

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(g) ZINN. de oculo, citat. HALLER, El. Phyſ. T. iv. p. 321.

(*h*) The celebrated WHYTT's objections to particular ſympathies, ariſing from a connexion of nerves in Ganglions, ſeem inconcluſive: for, ſays he, ſuch a communication as is ſuppoſed in Ganglia to occaſion ſympathy would cauſe *a confuſion* in our ſenſations; as well as in the *motions* of our muſcles. With reſpect to *ſenſation*, we have ſeen that *confuſed* or *indeterminate ſenſation* is proper to parts whoſe nerves ariſe from Ganglions; and that the muſcular motions of theſe parts are

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IT is objected alſo, “ That every voluntary muſcle in the body becomes involuntary when it is ſtrongly ſtimulated: for example, the *Acceleratores Urinæ,* are quite *voluntary* in the Action of *expelling the Urine,* but act *involuntarily* in *expelling* the *ſemen*.”

G 2 When

are not regulated by the Will, but by the application of an irritating cauſe; and therefore, inſtead of proving that ſympathy in the Abdominal viſcera does not ariſe from Ganglions; they render it likely that it does. The Mind undoubtedly feels ſympathetic as well as all other ſenſations only at the origin of the nerves in the Brain, where the Soul ſits enthroned: Yet facts incline me to think with WILLIS, VIEUSSENS, HALLER, and MONRO, that *ſympathy* depends in *many caſes* upon the *connexions* of nerves *in their courſe,* as well as *at* or *near* their *origin.*

It is well known, that an irritating cauſe acting upon a nerve in any of the limbs, will ſometimes extend its efficacy as far back as the Brain and occaſion *convulſions,* or Epileptic paroxyſms affecting the whole Body ſympathetically; at other times it only affects ſome particular parts of the Body, as in the caſe of the locked Jaw, ſpaſmus Cynicus, and various other inſtances which I purpoſely omit. In like manner any violent irritation, which by its ſtimulus affects any of the filaments of the intercoſtal nerves up to their origin in their reſpective Ganglions, will alſo act by conſent upon, and affect all the filaments which have their common origin in ſuch Ganglions: And hence ſympathetic ſymptoms will ariſe in the firſt place, in the parts of the Abdomen

SECT. IV. WHEN we conſider the ſtate of the Soul and Body under any violent paſſion of mind, we find the uſual operations of the Soul itſelf are not only diſturbed, but thoſe parts of the Body too, which the Will cannot controul, are now agitated by the ſtorm; for every one has experienced that the heart and Viſcera in general are vehemently affected by ſtrong paſſions: the mind is in like manner violently re-acted upon by very ſtrong bodily ſenſations; for it is well known that muſcular parts which are ordinarily ſubject to our volitions, ceaſe to be ſo, if any part is ſtimulated

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Abdomen and Thorax ſupplied by the great ſympathetic nerves, and afterwards in the reſt of the Body, nearly in the order in which theſe nerves are connected with the reſt of the nervous ſyſtem. The Reader will find that the celebrated DE HAEN has adopted the WINSLOWAN opinion, that the Ganglions are the origin of the intercoſtal nerves, and attempts with great probability to explain from thence the ſingular paralytic ſymptoms ſometimes left by Saturnine Cholic. This general account of ſympathy is ſupported by ſo many facts, that I think one may ſafely venture to foretel, it will derive proof and confirmation from ſuch new diſcoveries as will advance the knowledge of the nerves, and enable future ages to ſee things clearly on this ſubject, which at preſent are dark and inexplicable to us.

mulated by exquiſitely pleaſing, or exceſſively painful ſenſations; under ſuch a ſtimulus they are neceſſarily contracted or convulſed. But, it is not therefore to be concluded, that the gentle ſtimulus of the Blood, on the ſurface of the Heart, and of the air, food, and gaſtric juices, on the Inteſtines, of which the mind has no conſcious perception at all, much leſs a diſagreeable one, can lay it under any ſimilar neceſſity, as ſome have argued. This objection can have no force againſt our doctrine, however it may recoil upon that of others; as all voluntary muſcles whatever may be excited to contractions by irritations exceſſively pleaſing or painful; the contractions from ſuch cauſes being involuntary, neceſſary, and uncontroulable: But the ſtimuli that affect the Heart and other parts, whoſe motions are naturally involuntary, are not of this claſs, nor of this ſtrength; and indeed,

deed, are ſo little perceived by the mind as to lay it under no ſuch neceſſity, as in the inſtance objected. Thoſe on the contrary, who, obſerving that we are not conſcious of theſe motions, infer from thence that the ſelf-thinking individual or human Soul, is not the real author of them; and who inſtead of refering them to unknowing Nature, attribute them to its great Director, ſeem to me, to reaſon very concluſively (*i*).

To

(*i*) See BAXTER's Inquiry into the nature of the human Soul. A performance in which the juſteſt notions of the Soul's authority in and over our Bodies, and of the divine government co-operating therein, and controuling univerſal Nature, are excellently deduced and ſupported upon the foundations of ſound reaſoning and true Philoſophy.

" The great myſterious Being, who made and governs the " whole Syſtem, has ſet a part of the chain of cauſes in our " view; but we find, as he himſelf is too high for our compre- " henſion, ſo his more immediate inſtruments in the univerſe " are alſo involved in an obſcurity that philoſophy is not able to " diſſipate; and thus our veneration for the ſupreme Author is " always increaſed in proportion as we advance in the knowledge " of his works: as we arrive in philoſophy towards the firſt " cauſe, we obtain more extenſive views of the conſtitution of " things, and ſee his influence more plainly: we perceive that " we are approaching to Him, from the ſimplicity and genera-

" lity

To what other immaterial power can we refer the ſupport of the vital motions, which have for their cauſe irritability? a principle or cauſe not immediately extinguiſhed by Death itſelf, and which exiſts in the heart and inteſtines, not only, when they are ſeparated from the Head, and the reſt of the Body; but when divided into a thouſand parts, each piece retains it.

Is it then an inherent property of muſcular fibres? Sound Philoſophy teaches us, that activity in matter can never be inherent, but muſt be impreſſed by ſome immaterial, and as ſeems probable, in the preſent caſe, active percipient power.

As irritability exiſts in muſcular fibres ſeparated from the Body, the Soul does

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“ lity of the laws or powers we diſcover, from the difficulty we “ find to account for them mechanically, from the more and more “ complete beauty that appears, &c.” MC. LAURIN's View of Sir ISAAC NEWTON's Philoſophy. Cap. I.

SECT. IV. does not ſeem to be that active power. For the Soul is ſeated in the Brain only, and is acted upon, and puts muſcles in action by means of nerves (*Prop.* 4, 5.) continued from the Brain. Hence when the nerves are compreſſed, tied, or cut through, the Soul loſes its power, and yet, Irritability remains, even in muſcles of the voluntary claſs. Thoſe that are involuntary, and over which the Soul has no authority at any time, poſſeſs this property nevertheleſs, in the moſt eminent degree.

DETRUNCATIONS of the Body, diminiſh not the faculties of the Soul, which remain perfect unleſs the Brain be injured. The Soul is not a diviſible or diſcerptible ſubſtance.

IRRITABILITY therefore, tho' capable of being occaſionally excited by the

the ſoul, as a kind of irritant, through the medium of the nerves, ſeems to have a different percipient agent for its cauſe, and to be derived only from that immaterial Being, who created all Bodies, is the ſource of all active force that appears in them, and preſides over the univerſal frame of nature.

I SHALL not enlarge this digreſſion, by endeavours to explain, how the *Soul* acts upon the *nerves*; and how, by means of theſe, the irritable muſcular fibres, are by an act of the Will made to contract: how the more violent agitations of the Soul, by the medium of the nerves, affect the irritable, but involuntary vital organs. What the nerves contribute towards the contractions of *muſcular fibres*, and how far their efficacious energy is neceſſary to ſuch contractions (*See Prop.* 6).

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THERE is in all fibres of animal Bodies, even thoſe of the cellular kind, a natural contractibility and power of retraction, which appears equally in living and dead Bodies, whether warm or cold.

MUSCULAR fibres poſſeſs this power of retraction along with that of irritability, which ſeems proper to them alone in their living ſtate; at leaſt, it vaniſhes ſoon after Death, and is not capable of being excited when muſcles are thoroughly cold in conſequence of death *(k)*.

THIS property of irritability in muſcular fibres, ſeems not only capable of being excited and regulated by means of the nerves, but is alſo manifeſtly capable of increaſe by nervous power: yet Polypes,

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(k) Te deciſa ſuum, Laride, dextera quærit,
Semianimeſque *micant digiti*, ferrumque *retractant*.
Virg. Æn. x. 395, 396.

pes, and perhaps ſome of thoſe plants called ſenſitive, are highly irritable, tho' ſaid to be deſtitute of nerves: if this aſſertion be ſufficiently grounded, it would then ſeem that irritability has no neceſſary dependance upon nerves, but may exiſt in muſcular fibres without them. This property, however, in muſcular fibres, in connexion with nerves, is productive of voluntary motion at the nod of the mind; and is alſo productive of involuntary motion by the action of a ſtimulating fluid upon the nerves ſpread over the internal ſurface of the heart and inteſtines; ſo that, tho' we may have animals, formed without nerves, highly irritable, and active, in conſequence of this irritability: yet, in ſuch animals as have the nervous and irritable ſyſtems united; the dependance of irritability upon the nerves, in conſequence of that union, ſeems ſo great as not eaſily to be, even in imagination, ſeparable from them.

WHAT we know only with certainty is this ſingle fact, that the nerves connect the Soul and the Body together: That by them the Soul acts, and is acted upon: How theſe things are performed is intirely unknown to us, and will probably ſo remain, at leaſt, till new diſcoveries are made in the nervous ſyſtem.

THOUGH no poſitive doctrine of any great importance has yet been educed from the late reſearches and experiments, concerning the nature of the irritable fibres of animals and their nerves; theſe reſearches ſhow that many things hitherto firmly believed concerning them, are merely ſuppoſititious. From the effects of ſtimuli on the nerves and muſcular fibres, from the excited contraction bearing no proportion to, and often far exceeding, the force with which the ſtimulus was impreſſed; in fine, from the evident marks of life, and ſomething reſembling ſenſibility in theſe contractions, it ſeems clear, that the origination of muſcular action is not likely to be accounted for by any hydraulic law or mechanic power: And the ſuppoſitions of ſubtile fluids, called *Spirits*, flowing in nerves as canals, or of an Electric Aura *conducted* by them, or of vibrations like elaſtic ſtrings, are not only aſſumed without proofs, but are all equally inapplicable in all points to appearances, and inſufficient to account for the communication of motion from the brain to the muſcles.

To unfetter the mind from error, prepares it for the inveſtigation and diſcovery of truth. A real conviction of the imperfection of our knowledge of the

SECT. IV. the nerves, which has of late been gaining ground and acquiring ſtrength from many laudable attempts to remove thoſe defects, affords a happy preſage that the acquiſition of true and important knowledge in this dark region of animal ſtructure, is not far off. Yet we muſt remember, that ſcience may be defective, when it is not illuſory or totally falſe. For in the firſt gleams of light, and the firſt conceptions of truth itſelf, concerning ſubjects that border on the limits of human knowledge, difficulties will abound, and the darkneſs, which terminates our proſpect, muſt neceſſarily cloud and obſcure its confines.

LASTLY, it has been objected, That "tho' the motions of the Uvea are involuntary, from light affecting the "eye; they are truely voluntary, "when it contracts in order to the "diſtinct viſion of an object placed "near

" near the Eye, whoſe minute parts " we want to obſerve accurately." SECT. IV.

IT is an excellent *Maxim* laid down by Sir ISAAC NEWTON, That " Conclusions drawn from experiments " and obſervations by induction, are " not to be ſhaken by any objections " but ſuch as are taken from experiments, or other certain truths." The diſtinction formed in this objection is the off-ſpring of the School of STAHL, and has no ſupport from experiment and obvious matter of fact; but ſeems verbal and hypothetical only. This will appear, if we conſider that the Uvea always dilates, when the diſtance of an object increaſes, and in an obſcure light. Dilatation is the natural ſtate of the Pupil, and a faint image or weak light making but little impreſſion upon the Retina, and a ſtrong light and near object (which always reflects a more vivid image than a diſtant one) making a ſtrong impreſſion upon it, the Pupil is more contracted by the laſt, and leſs by the firſt. That the contractions of the Pupil, are never voluntary, but always ariſe from ſenſations of the Retina, uniformly and involuntarily, by an invariable law, appears by experiments and diſeaſes: And hence it is, that the Pupil conſtantly becomes immoveable and greatly dilated, when by a Gutta ſerena the Retina becomes inſenſible. The great man, to whoſe precious ſtores we have been ſo often indebted in the courſe of this inquiry, has furniſhed experiments, which prove that the Iris or Uvea, like all other parts provided with nerves from Ganglions, has but a dull degree of feeling, and is moved intirely independent of the Will: "What perſuades me, that the Iris is "much leſs ſenſible than the Retina, "is, that if, after having pierced the "Cor-

"Cornea, you irritate or cut the Iris, it "is not therefore contracted; whereas "the leaſt increaſe of light makes it "contract: which evidently proves that "this contraction does not depend upon "the proper ſenſibility of the Iris, but "on the Retina: the Gutta ſerena ſerves "to prove the ſame thing; the Iris being no ways changed in that diſeaſe, "any farther than it is deprived of motion from the ſenſation of the Retina "being deſtroyed by a palſy of the "Optic nerve (*l*)." And whoever will obſerve the motions of the Pupil by means of a mirrour, will find the Will has no ſort of power over them.

(*l*) See Baron HALLER's Eſſay on Irritability, p. 31. and Element. Phyſ. T. v. p. 374—378.

NB. [illegible]

SECTION V.

Some Diſeaſes conſidered briefly with relation to Ganglions.

SECT. V.

FROM what has been ſaid, I think it appears, that Ganglions are organic parts of great importance in the nervous ſyſtem, and animal machine. That they limit the powers of volition, will, I flatter myſelf, appear a doctrine fairly inferred, by an induction, little, if at all, ſhort of being complete: we may therefore venture, upon theſe grounds, to conſider ſome of the ſubordinate effects of Ganglions in our machine; ſome of which we have already hinted, and which, I doubt not, will be much more extended by thoſe who ſhall ſucceed

ceed me in this reſearch: the coaſt is diſcovered, and others I hope will gather its riches.

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IN ſleep, and in apoplexies, the external ſenſes ceaſe to convey impreſſions to the Soul; and the exerciſe of voluntary motion is ſuperſeded; but the vital functions have in theſe circumſtances the ſame, and ſome have believed a greater, ſtrength and vigour than before: the truth ſeems to be, that what is wanting in the frequency and number of Reſpirations and of Pulſes, is made up, by their greater deepneſs and fulneſs. In ſleep, this temporary interruption of ſenſation and voluntary motion, ariſes from the nervous power being exhauſted, which by a few hours' reſt is conſtantly recruited; and with it, a ſtate of vigilancy returns, in which the whole animal machine, its ſenſes, voluntary as well as involuntary motions, are in complete action.

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APOPLEXIES ariſe from ſome extravaſated fluid, or other cauſe, compreſſing the Brain in ſuch a degree, as to put an end to its functions, (if not removed) and thoſe of external ſenſation and voluntary motion, depending upon them.

IT has been a queſtion long agitated, why in Apoplexies, the ſame compreſſion does not intercept the nervous power, by which the *vital* functions, and *animal* functions are both ſupported: and how it happens that the heart continues to move, and the reſpiratory organs to act, for a conſiderable time after ſenſe and motion in the other parts ſeem to be at an end?

SOME eminent Phyſicians have attempted to ſolve this queſtion, by confining the cauſe of Apoplexies to the Brain only, from whence they ſuppoſed

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all the ſenſory nerves, and thoſe ſubſervient to voluntary motion, were derived: and that the Cerebellum remained uncompreſſed, becauſe of the ſtrong and tenſe membranes, which are interpoſed betwixt it, and the Brain; and that the vital organs from thence were ſolely ſupplied with nerves (which is far from being true): and this, they imagined proved by ſome experiments, in which wounds of the Cerebellum were found to occaſion immediate death in various animals.

BUT it being obſerved by others, that the worſt wounds of the Cerebellum had ſometimes healed, and that not much difference, as to danger, could be obſerved, betwixt deep wounds of the Cerebrum and Cerebellum: and that Fœtus's at their full time have been born alive, though deſtitute both of Brain and Cerebellum: and lately it having

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having been found that the ſpinal marrow may be cut through near its origin, and the eighth pair, and great ſympathetic nerves divided, by which all communication both with Brain and Cerebellum is cut off, yet, to the aſtoniſhment of beholders, the heart continuing to move for many hours afterwards, this theory falls of courſe; and we are obliged to ſearch out ſome other cauſe, which may account for this phænomenon, in a more ſatisfactory manner.

I AM not without hopes, that the doctrine we have advanced concerning the nature and uſes of Ganglions of the great ſympathetic nerves, will afford a natural ſolution of this difficult Problem. The great ſympathetic nerves being truly derived from the ſpinal marrow, have in the numerous Ganglions proper to them, ſo many receptacles of nervous energy, ſo many ſub-

ſubordinate Brains, which continue to diſpenſe the nervous energy to the vital organs, long after they ceaſe to have communication with the Brain; and ſupport the *Irritability* of the heart, *which* makes it ſo long ſenſible to the ſtimulus of the blood flowing into its Auricles and Ventricles after the reſt of the machine is in fact dead: but, as the whole nervous ſyſtem derives its energy from, and ultimately depends upon, the Brain and Cerebellum; theſe ſubordinate ſources of nervous energy, being at length exhauſted, without a poſſibility of a new afflux from the brain, the vital organs at length ceaſe to move.

THIS reaſoning ſeems ſtrongly confirmed by thoſe Fœtus's already mentioned, which come into the world without any Brain or Cerebellum: theſe generally have the medulla ſpinalis large enough

enough to ſupply the great ſympathetic nerves: and by theſe nerves, the force of the heart, the circulation, and developement of the organs of the Fœtus, are ſuſtained in the mother's womb; for as ſoon as they loſe the Mother's foſtering heat, they die; if not dead before their birth.

'BY the inter-communion of nervous energy ariſing from the numbers of Ganglions on the great ſympathetic nerves, we underſtand alſo, how, and by what means, the vital and involuntary powers of our machine go on unimpaired in perfect Hemiplegias, which reduce one half of the animal body to a ſtate of mere vegetative life, the muſcles of one ſide being no longer obedient to the Will: When this is thoroughly conſidered, it will be found a ſtrong proof of our doctrine: for, if the filaments of the nerves were not in-

interrupted by, and intermixed in, Ganglions, in their courſe from the Brain to the Viſcera; but were continued threads or canals, as they are from the Brain to the ſenſory organs, and voluntary muſcles; a very manifeſt defect muſt have appeared in the functions of the viſcera contained in the Thorax and Abdomen, by the loſs of half the nervous power diſtributed to them: that is, a greater defect muſt have happened in every Hemiplegia, than ever happens in any one.

IT ſeems conſiſtent with this view of Ganglions, as ſubordinate origins of nerves ſent to the inteſtines, yet, ultimately derived from the Brain; rendering ſenſations leſs determinate, yet, not precluding them in an indiſtinct way from reaching the ſenſorium commune: It is, I ſay, natural to expect from, and conſiſtent with this doctrine, that

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ſuch cauſes as very conſiderably compreſs the whole brain, or ſpinal marrow near the head, ſo as to intercept external ſenſation, will alſo blunt very conſiderably the ſenſation, and leſſen the irritability, of the parts to which the intercoſtal nerves are diſtributed: this indeed actually happens in dangerous attacks of the Apoplexy, in which the moſt irritating medicines, the moſt violent and ſtimulating cathartics, in doſes, which at other times would be poiſonous, are often inert and ineffectual, from the unfeeling ſtate of the Inteſtines: this alſo happens when the ſpinal marrow near the head is greatly compreſſed, of which we have a curious inſtance in the laſt volume of *London* medical obſervations (*m*). But in other

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(*m*) See Medical Obſervations by a Society in *London*, Vol. iii. Art. xviii. p. 160. and M. DU VERNEY's obſervation in Reg. Scient. Acad. Hiſt. Lib. III. DU HAMEL, p. 264. We have alſo curious inſtances of the ſame kind in the very uſeful and intereſting Inquiry into the efficacy of warm bathing in Palſies, by the other caſes, where I have known the ſpinal marrow compreſſed, though leſs conſiderably, and at a greater diſtance from the brain; this effect has not followed: when that total compreſſion is but a little removed, and the nerves of one ſide only, as in the Hemiplegia, or perhaps ſtill fewer than half the nerves, paſs down the ſpine free from preſſure; then the inteſtines *altogether* recover their ſenſibility, and the heart continues to act with its wonted vigour; by which we know, that by

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the ingenious Dr. CHARLTON.——*John Waterman*, aged 34, by a fall, had the third and fourth Vertebræ of his Neck diſtorted. The paralytic effects of this diſtortion, which remained when he was admitted into the *Bath* Hoſpital, and which were ſoon removed by pumping upon the neck, (the Vertebræ gradually ſliding back into their natural ſituation) were, a palſy in his lower limbs, and a monſtrous diſtenſion of his belly, which was ſore to the touch, and if ſtruck on, ſounded like a drum; he was coſtive, and it was with the utmoſt difficulty he parted with his Urine. The ſwelling of the belly ſubſided by great diſcharges of wind from the ſtomach, and in proportion to its decreaſe, the action of the bladder and the periſtaltic motion of the bowels were reſtored with the perfect uſe and feeling of his limbs, p. 58. See alſo Mrs. *Whitby*'s caſe, ibid. p. 31.

SECT. V. ſome communication of the nerves in Gangſions, analogous perhaps to an Anaſtomoſis, the functions of the Viſcera are carried on ſufficiently.

I MIGHT go on, to confirm the reality of ſuch a communication of nerves in Ganglions, by various phænomena in other diſeaſes, which plainly point it out; and to account for the production of ſympathy, in many caſes, in conſequence of that connexion. I might alſo ſhow, that Ganglions probably have ſome uſe in Secretion, by ſecuring a more uniform motion of the liquors in the ſecreting organs; but ſuch diſcuſſions as theſe would lead me into a very wide and uncertain field of Phyſiological diſputation: it would be more my inclination, by purſuing the ſame clue of obvious facts and experiments, to try to make ſome advances in the knowledge of nervous diſeaſes, which being ſo near the ſeat of the mind itſelf, afflict it more ſenſibly than thoſe which affect the nerves leſs, and are thereby more remote from the mind: changeable beſides, and intricate in themſelves, they ſeem to have been rendered more ſo, by the wild and hypothetical manner in which they have been for the moſt part conſidered. The moſt precious truths, even on that forbidding ſubject, may be more within our reach than we are aware of, provided we adhere cloſe to the method of obſervation in our reſearches, and carefully diveſt ourſelves of prejudices ariſing from received Theories, which, involving the mind as in a miſt, render it leſs apt to perceive and admit the truth: but I leave this exquiſite taſk to thoſe who have abilities proportioned to its importance; to the HALLERS and TISSOTS of this, and the BOER-

BOERHAAVES and WHYTTS of ſucceeding ages.

——Nec meus audet
Rem tentare pudor, quam vires ferre
recuſent.

I SHALL therefore now finiſh this Eſſay with a recapitulation of the principal matters endeavoured to be proved in it; and with reflections not unſuitable to my ſubject.

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Recapitulation--final cauſe of our vital motions being involuntary.

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THE Ganglions, reſpecting their ſtructure, may juſtly be conſidered as little brains, or germes, of the nerves detached from them, conſiſting of a mixture of cortical, and nervous medullary ſubſtance, nouriſhed by ſeveral ſmall blood veſſels, in which, various nervous filaments are collected, and in them loſe their rectilinear parallel direction, ſo that a new nervous organization probably takes place in them.

RESPECTING their uſes, Ganglions ſeem the ſources, or immediate origins of the nerves, ſent to organs moved in-

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involuntarily; and probably, the check or cauſe, which hinders our volitions from extending to them.

GANGLIONS ſeem analogous to the brain in their office: ſubordinate ſprings, and reſervoirs of nervous power, they ſeem capable of diſpenſing it, long after all communication with the brain is cut off. And tho' they ultimately depend upon the brain for its emanations, it appears from facts, that, *that* dependance is far from being immediate and inſtantaneous.

FROM the Ganglions ſerving as ſubordinate brains, it is, that the vital organs derive their nervous power, and continue to move during ſleep: and, to the ſame cauſe, as well as to its greater irritability, we may refer the continuance of the motion of the heart, ſo much longer than that of the voluntary

luntary muſcles, in perfect apoplexies. From thence too, the motions of the heart receive for ſome time, ſupport, even after the ſpinal marrow and the intercoſtals in their deſcent along the neck, are cut through: ſo that animals ſurvive this experiment ſometimes thirty hours, which however proves at length certainly fatal, by cutting off all communication with the prime fountain of nervous emanation.

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IN a word, *Ganglions* limit the exerciſe of the Soul's authority in the animal œconomy; and put it out of our power, by a ſingle *volition*, to ſtop the motions of our heart, and in one capricious inſtant irrevocably to end our lives.

HOWEVER in the dark we may be, what ſubordinate agents are employed by an *Almighty Arm*, to wind up, and

SECT. VI. regulate this delicate machine, and ſo uniformly to guide and direct, independant of us, our vital and involuntary motions, we muſt at leaſt clearly diſcern the goodneſs, and unerring wiſdom of our CREATOR acting therein, though by ways paſt finding out, for our preſervation and ſecurity.

BEING thus led up to this exalted truth, the natural and happy fruit of my ſubject, I hope to be excuſed expreſſing more at large (though ſtill in a very ſummary, and imperfect manner), my ſenſe of it, and in giving a curſory glance, at the *final cauſe* of a contrivance, by which we live.

RESEARCHES carried far into nature, conſtantly lead us to traces of an All-governing DEITY, exerciſing a ſovereign authority over HIS works. The motions of the largeſt maſſes, and moſt minute

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nute particles of matter, all performed with the ſame order and eaſe, and regulated by laws ſurpriſingly ſimple and extenſive, penetrating the inmoſt receſſes of bodies, and extended throughout the *univerſe*, evince the direction of an omnipreſent almighty Power actuating the whole.

In every part and operation of nature, the fitneſs of things to one another, and *one deſign*, and their ſubſerviency to the beſt ends, and to the uſe and felicity of intelligent Beings, point out the conſummate wiſdom and goodneſs of *One* great *Artificer*, *One* original *Mind*.

The *courſe of Nature* is undoubtedly the effect of the inceſſant direction of the Deity, no leſs than its creation and original arrangement: it ſeems impoſſible, and incomprehenſible, that

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any mechanical power, any organization of mere matter, could of itſelf, without direction or art, produce vegetables and animals, all machines of exquiſite conſtruction, at all times and every where ariſing into being in amazing profuſion: taſting life, and by an eſtabliſhed order, made inſtinctive and blind inſtruments to beſtow it on others, and then retiring from this ſtage of exiſtence after a ſhort appearance upon it. But,

———" *The univerſal Cauſe*
Acts not by partial, but by general Laws."

BY ſuch laws originally eſtabliſhed to ſecure the uniformity of nature, the conſtancy of cauſe and effect, and the permanency of ſpecies; GOD directs the ſucceſſive *evolutions* of the animal and vegetable tribes. The verdure of the field, and all its flowery plants, the humble ſhrubs, and the loſty trees, in infinite variety, are his conſtant care, as well as his bounteous gift. Sole giver of life HE inſpirits with animation, the meaneſt inſect, and moſt abject reptile, no leſs than the more perfect and nobler animals, and by HIS wiſdom guides them all to the ſeveral ends of their exiſtence (*n*).

EVERY

(*n*) This a truth deduced from the moſt profound examinations into nature, as well as, apparent from a ſuperficial ſurvey of it, and agreeable to *common ſenſe.*

'Tis a truth proved and confirmed by the diſcoveries of a HALLER and a BONNET, as well as by the reſearches of the ableſt interpreters of nature in all former times. By thoſe of ARISTOTLE, CICERO, GALEN, BACON, BOYLE, NEWTON, MC. LAURIN, who concur in demonſtrating that the laſt *Link* in the *Chain* of natural cauſes terminates at the throne of GOD.

In vain have various perſons endeavoured to give a ſatisfactory account of the origin of organized Bodies by any mere mechanical operation ; as eaſily might we conceive a Watch capable of producing its like without a Maker. The efforts of a modern writer of great genius in favour of this cauſe, have not given more ſatisfaction than thoſe of DEMOCRATES and DES CARTES formerly gave. Happy in overturning the *falſe* ſyſtem of generation founded on the obſervations of LEEWENHOECK, he has built upon its ruins one, no leſs imaginary, and in all reſpects more exceptionable.

The Microſcope, indeed, diſcovers to us, not only in the *ſeminal liquors* of animals of *both ſexes,* but alſo in infuſions of all kinds

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EVERY thing, in fine, on Earth and in the Heavens, manifeſts and preſents HIM to us; and in the wonders of the

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kinds of animal and vegetable matter, *Animalcules* ſmall and various beyond all conception, but ſtill poſſeſſing every characteriſtic of a living and complete animal.

Though theſe Animalcules are over-rated in the LEEWENHOECKIAN ſyſtem of Generation; they are under-valued in that of DE BUFFON, and have, like ignes fatui, led both into miſtakes.

To call theſe microſcopic Animals, particles of mere *unorganized matter, ſelf-moved, and ſelf-active—organic particles, unorganized, but tending into organization, & une matiere vivante,* is a prodigious petitio principii, and abuſe of language.

But ſtill, in order to evade the acknowledgement of art in the formation of animals, it is ſaid, Theſe organic particles are determined to this or that ſhape, are organized, by means of animal *Moulds:* this is ſtill aſſuming what is deſtitute of proof, and ſaying what cannot be conceived or underſtood, if any thing elſe is thereby meant beſides the aſſimilating power of a body already formed. In any other ſenſe, moulds capable of forming machines ſo complete, ſo aſtoniſhing, of imparting form, external and internal, order, connexion, motion, life, with ſuch amazing exactneſs and propriety, in machines conſiſting of ſuch a prodigious variety of parts, would be more wonderful than the machines themſelves: they explain nothing, and inſtead of ſhowing how animals may be made without art, they ſuppoſe a higher exertion of it; but an exertion paſſing all comprehenſion: and this celebrated *modern* ſyſtem, with all the embelliſhments of eloquence, and ornaments of language, has not the credibility even of a Romance.

The *vital* and eſſential parts of animals could not have ſubſiſted *ſeparately,* or been produced one after another, but muſt have the loweſt, as well as the moſt magnificent of HIS works, the underſtanding with tranſport traces the perfections

of

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have been one coæval ſyſtem, formed at once, and connected together previous to what is called *Generation*, which is in fact only the occaſion of the growth and increaſe of theſe Rudiments of a nervous and vaſcular ſyſtem in bulk and ſtrength, and into ſuch parts, as are capable of ſhooting and vegetating from them.

If it be admitted as eſſential to animal life, that the heart ſhould receive its nervous influence from the brain, and the brain its nouriſhing blood, and the liquor it is to ſeparate for the uſe of the nerves and the purpoſes of muſcular motion and ſenſation, from the arteries; and, that a part of theſe fluids ſhould again return to the heart by the veins: it is eaſy to perceive that in the generation of animals, a heart and a brain, and their communicating veſſels, and mutual dependencies, could never be produced at all, much leſs produced at once, by the circulation of the different liquors of the parent animal in their proper veſſels, or by any alteration theſe liquors undergo in the *organs of ſecretion or of generation:* and that the production of an animal, is a work not to be effected by matter and motion alone, and is ſuperiour to all mere mechanical means.

Good obſervations and juſt reaſonings lead us to conclude, that all plants and all animals whatſoever, in their ſeminal ſtate, are preformed, and that their eſſential parts exiſt in miniature; but in a dormant and inactive ſtate, very different from that of *microſcopic animalcules*, or moving *particles* ſeen by the aid of *Microſcopes*.

Fecundation puts this germinating principle, this *bud of Being*, peculiar to every ſpecies, into life and action. The male ſperm ſtimulates the little heart, and rouſes it into motion, and gives occaſion to a circulation of liquors in organs prepared for it,

but

of a CREATOR, who is not far from every one of us, and in whom we live, move and have our being; ſees HIS fingers touching the keys of nature, producing harmony in the univerſe; and HIS omnipotent arm unwearied for

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but till then at reſt; it is thus the means of nouriſhing, enlarging and unfolding what already exiſted, what was already formed and created, but creates nothing. Creation is the work of GOD alone. As HE IS *our* true Father, and all plants and animals which are, have been, or ſhall be upon the earth, are indeed the immediate productions of HIS hand.

If it be found impoſſible to account for the re-production of animals by equivocal generation, or by any mere mechanical operation; and, in order to obtain ſome tolerable comprehenſion of this great myſterious work, we muſt have recourſe to ſuperintending intelligence, and refer the generation as well as formation of animals to the art and power of GOD; I ſee no reaſon why, to the excluſion of the ſame active principle, we ſhould very anxiouſly ſeek to refer the involuntary and vital motions of animals to mechanical cauſes alone, or to any other than to their original mover; eſpecially when we conſider that theſe motions ſeem deſignedly with-held from the volitions of our own minds, and that, unconſcious of them, we neither deliberate concerning them, nor even find them obedient to the authority of our Will.

The many unſucceſsful attempts of ingenious Phyſicians to account for theſe motions on the principles of mere mechaniſm, ſhould convince us of the vanity of ſuch attempts, and that they labour under ſome inſuperable difficulty. Nor can the doctrine of STAHL, who refers all theſe motions to our ſoul, be admitted for ſo many ages ſuſtaining, conducting every thing.

But we ourſelves are an abridgment of the univerſe, and, with reverence be it ſpoke, contain within us the image of its CREATOR; and were it poſſible not to trace HIM in that vaſt Theatre where HE exerciſes HIS power and wiſdom with ſuch magnificence, we might nevertheleſs contemplate HIS Being and Attributes diſplayed in our ſtructure, and exerciſed in our preſervation.

ted, 'till, the adherents to his ſect inform us, when the ſoul firſt began to be cloathed with body, and aſſumed the direction of its œconomy, and operations, of which, after all our reſearches, we remain ſo ignorant: when it firſt ventured to let the heart pant, and imparted motion to the vital parts; and when it exerciſed the power of ſuſpending and renewing theſe motions: 'till, I ſay, we are better ſatisfied in all theſe particulars, it will be moſt rational as well as decent, to refer the carrying on, and direction of, the vital and involuntary motions of animals, with their formation, to the DEITY by whom, indeed, we are fearfully and wonderfully made and preſerved.

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THE mechaniſm of our body, the connexion and ſubſerviency of all its parts to a common purpoſe, the exquiſite contrivance of its organs, conſiſting of all the various orders of veſſels, interwoven with wonderful art, have led Anatomiſts in all ages to acknowledge an infinitely wiſe and powerful Maker. Among the moſt precious remains of antiquity, are thoſe commentaries of GALEN, wrote on the uſes of the parts of the human Body, as hymns and offerings of praiſe to the great CREATOR of it. Is it, indeed, otherwiſe conceivable how ſuch conſiſtency and harmony could have taken place in the different parts of our wonderful frame? How they could have been ſo exactly fitted to each other, and to the exterior objects, which have an evident relation to them, and the ſyſtem they compoſe? Could the bones and muſcles have been ſo well diſpoſed for motion,

motion, without a ſuperior knowledge in mechanics? The Eye ſo admirably adapted to admit light and appropriated to viſion, was it formed without a knowledge of optics? Or the Ear, without the ſcience of ſounds? To attribute contrivances like theſe, and even Underſtanding itſelf, to unintelligent cauſes, rather than to the all-wiſe Parent of Nature, ſeems an incomprehenſible perverſion of Reaſon and Philoſophy.

FROM the curious ſtructure of our bodies we infer the wiſom and power of our Maker; but in the conſtitution and operations of our rational Souls, Man's nobleſt part, and true eſſence, the image of GOD is impreſſed and delineated, and HIS government of the univerſe exemplified, more eſpecially in the conſcious exerciſe of that power, by which, we, as free agents, are capable

SECT. VI. pable of exciting an infinite variety of movements in our bodies, all of them depending upon, and regulated by our volitions; while others go on with a ſeeming ſpontaneity and independance, and begin and end only with life itſelf.

EVEN our inclinations and paſſions, thoſe ſources of ſo much apparent ill, are, by the DEITY, providently rendered the means of our preſervation both as individuals and as a race: and an inſtinctive affection for theſe ends and thoſe means, powerfully operate upon us, and like two different powers acting in one direction, conduct us with redoubled force to the ends intended by our Maker to be produced by them. Theſe important ends are always leſs ſecured by our inſtinctive love of life, fear of death, and natural deſire of progeny, than by the more vehement appetites and inſtincts, which allure us to to the exerciſe of certain faculties more immediately as gratifications, than as the efficient means, which by experience are known to fulfill the purpoſes of nature: and theſe inſtincts have in common with every ſpring of action infixed in our frame, a ſtrength and impetuoſity capable of carrying us too far, the more certainly to ſecure their efficacy as incitements to the great ends of animal life.

YET, the love of life and all its enjoyments, and the fear of death and all its dreaded harbingers, would have been but inſufficient ſecurities for our carrying on the vital motions, with that conſtancy and uniformity neceſſary to the preſervation of life, if theſe motions had depended on our will and choice. Reaſon would have deliberated concerning them with too much ſlowneſs, and volition would have executed them with a dangerous and fatal caprice. For, if the heart had been ſubjected to the Soul's authority as much as the voluntary muſcles are; if its motions could have been ſuſpended, or ſtopt with the ſame facility, Death would then have coſt us no painful pang: and, whenever the body was tortured by pain and diſeaſe, or the mind in anguiſh from grief or diſappointment, a remedy ſo eaſy to be applied, (an eſcape from all *preſent* miſery made by the very act, and in the inſtant, of choice) would have been recurred to with a dreadful frequency. Death, no longer armed with pain and terror, would in a ſhort time have extirpated the human race.

THE preſervation therefore, and ſecurity of life in every moment of it, depends upon our vital motions being entirely ſubject to the wiſe government of the Author of our lives; who charges

HIMSELF, with the immediate care, of them, and, of us.

ALL this, when attentively conſidered, muſt affect us with a ſenſe of GOD's goodneſs; *who*, tenderly reſpecting the imbecility of man's nature, hath been pleaſed by appetites and paſſions, to excite him to acts of ſelf-preſervation; and where the violence of theſe might have been hurtful, no leſs than the ſlowneſs and inſtability of Reaſon, hath taken our ſafety under his own more immediate direction.

THAT mind muſt be ſtrangely prepoſſeſſed and bewildered with falſe ſcience, which rather ſeeks for the cauſe of theſe involuntary motions in dead matter, organization, chance, neceſſity, ſomething that without knowledge or power, acts wiſely and powerfully, than in the great fountain of *Power*, *Wiſdom* and *Animation*. UN-

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UNLESS to ſuch, this field of ſtudy, (to uſe the words of an elegant writer), (o) "cannot be barren of Praiſe "to our CREATOR, nor unproductive "to ourſelves of that noble and uncommon union of ſcience and admiration, which a contemplation of "the works of infinite wiſdom alone "can afford to a rational mind; whilſt "referring to HIM whatever we find "of right, or good, or fair in ourſelves, "diſcovering HIS ſtrength in our weakneſs and imperfection, honouring "them where we clearly diſcover them, "and adoring their profundity where "we are loſt in our ſearch, we may be "inquiſitive without impertinence, and "elevated without pride; we may be "admitted (if I may dare to ſay ſo) "into the counſels of the Almighty by "a conſideration of HIS WORKS."

(o) Eſſay on the ſublime and beautiful.

THE END.